Double tension band osteosynthesis in transverse supracondylar distal humerus fractures and nonunions

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Abstract

Purpose The purpose of this study was to evaluate the objective and subjective results achieved after double tension band fixation in transverse extra-articular intracapsular supracondylar distal humerus fractures and nonunions in adults.

Methods Nine patients presenting six fractures and three nonunions of the distal humerus, treated with double tension band wiring between 1998 and 2011, were retrospectively evaluated. Two fractures were type A2 and four type A3, and the nonunions were oligotrophic; all nine lesions had a supracondylar intracapsular transverse orientation, that passed through the olecranon fossa, in a direction parallel to the joint line, and they compromised both columns of the distal humerus. Patient's age averaged 70 years (range, 56–82).

Results Follow-up averaged 24.6 months (range, 12–53). All fractures and nonunions united; there were no infections, elbow stiffness or heterotopic bone formations. DASH score at final follow-up averaged 14.2 points (range, 4–22). The analog scale of pain averaged 1.1 points (range, 0–3). Elbow range of motion averaged 100° (range, 100–120°). Flexion averaged 123° (range, 115–130°) and elbow extension loss averaged 15.5° (range, 10–25°).

Conclusions The results achieved with double tension band fixation in transverse extra-articular intracapsular supracondylar distal humerus fractures and nonunions are comparable to the results that can be expected when using other available fixation methods; this technique is faster, less demanding and cheaper, and surgeons should have it in mind when leading with these particular types of distal humerus fractures and nonunions.

Introduction

Distal humeral fractures in adults are frequently complex and technically demanding to manage. Although these lesions are rare, operative treatment is indicated in most cases. Their treatment has changed over recent years, mainly due to better imaging studies and the evolution in fixation approaches, techniques and implants. There is evidence that osteosynthesis using single screws, Steinmann pins and multiple K-wires, as well as postoperative joint immobilization in type C distal humerus fractures, are associated with poor results [1, 2]. The latest reviews in treatment of distal humerus fractures emphasize the fact that dual plate fixation, with placement of a separate strong plate on each column, is indicated for all adult fractures involving both columns of the distal part of the humerus [3, 4]; one author even states that failure to adhere to the principles of rigid fixation with a strong plate on each column can dramatically increase nonunion rates [3]. But, there are previous reports in the literature of comparable results achieved using double tension band osteosynthesis or combining tension bands with other fixation methods in supra and intercondylar humeral fractures instead of double plating for fixation of the condylar block to the shaft [5–7].

The objective of this paper was to evaluate the objective and subjective results achieved after double tension band fixation in transverse extra-articular intracapsular supracondylar distal humerus fractures and nonunions in adults.

Methods

We retrospectively evaluated nine patients presenting six fractures and three nonunions of the distal humerus, treated with double tension band wiring between 1998 and 2011 (Table 1). Pre-operative evaluation was performed using

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Table 1 Patients general information

Sex	Age	Pathology	Classification OTA/AO	Approach	DASH (preop)
Female	59	Fracture	A3	Alonso-Llanes	
Female	80	Fracture	A3	Alonso-Llanes	
Male	56	Fracture	A2	Bryan-Morrey	
Male	82	Fracture	A3	Bryan-Morrey	
Female	66	Fracture	A3	Alonso-Llanes	
Female	61	Fracture	A2	Bryan-Morrey	
Female	81	Nonunion	Oligotrophic	Alonso-Llanes	58
Female	69	Nonunion	Oligotrophic	Alonso-Llanes	73
Female	76	Nonunion	Oligotrophic	Alonso-Llanes	80

antero-posterior and lateral radiographs. Two fractures were type A2 and four type A3 of the AO/OTA classification, and the three nonunions were oligotrophic; all nine lesions had a supracondylar intracapsular transverse orientation, that passed through the olecranon fossa, in a direction parallel to the joint line, and they compromised both columns of the distal humerus (Figs. 1 and 2). Patient's age averaged 70 years (range, 56–82); seven were female and two male. All three nonunions were initially treated with cast; and the time between the initial fracture and definitive treatment in nonunions averaged 10.3 months (range, 7–13). Five patients had radiologic evidence of poor bone quality. One patient had pre-operative ulnar nerve symptoms. The pre-operative DASH score in the nonunion group averaged 70.3 points. Bone grafts were not used.

Patients were placed prone under general anaesthesia in five cases, and in lateral decubitus under regional anaesthesia in four cases; the arm was placed hanging over a radiolucent support, with the elbow hanging free in 90° of flexion, a tourniquet was not used. A posterior approach was used in all cases—paratricipital as described by Alonso-Llanes in six cases and a posterior triceps elevating approach through an extra-articular olecranon osteotomy as described by Bryan-Morrey in three cases [3, 4, 8]; in these last three cases the reflected triceps was reinserted using non-absorbable sutures placed transosseously. Either 1.8- or

2-mm K-wires were used; they were placed entering through the epitrochlea and epicondyle distally to the fracture line, without detaching soft tissues (other than the ulnar nerve, which was released, mobilized and protected throughout the surgical procedure). Once the K-wires were placed in the distal fragment, they were used as joysticks aiding in achieving reduction of the fractured fragment, and in the nonunions the fibrous tissues at the nonunion site were opened and anterior capsular release was performed through the nonunion before the K-wires were passed from the distal fragments to the columns. Two or three K-wires were used for each column; they were placed exiting through the opposite cortex, proximal to the fracture line in seven cases (Figs. 1 and 2), and in two cases they were placed intramedullary mimicking an Eiffel tower disposition. Once the K-wires were placed, a hole with a 2.7-mm drill was performed proximal to the fracture line on each side, and a 1.6- or 2-mm wire was driven through it, then crossed to make a figure of eight, and passed through the distal soft-tissues, distally to the entry point of the K-wires. Once both tension bands were in place they were adjusted simultaneously to achieve a compression as symmetrical as possible. Once the reconstruction was tensed elbow range of motion was checked to assess construct stability. **The ulnar nerve was transposed anteriorly and subcutaneously in all cases.** The arms were immobilized postoperatively in extension with a

Fig. 1 Transverse extra-articular intracapsular supracondylar distal humerus fractures. Alonso-Llanes paratricipital approach. Double tension band osteosynthesis, anatomic reduction and bony union

Fig. 2 Transverse extra-articular intracapsular supra-condylar distal humerus non-union; radiologic evidence of poor bone quality. Alonso-Llanes paratricipital approach. Double tension band osteosynthesis, shortening of the columns and bony union

plaster splint. Controlled active and passive elbow joint motion was started between the second and sixth postoperative day; the patients were instructed on how to perform the exercises at home three times a day and the remaining time they had the elbow in a sling for four weeks.

Final evaluation was performed using antero-posterior and lateral X-rays. Objective evaluation of range of motion was performed using a goniometre. DASH score was used for subjective evaluation; and pain at last follow-up was measured using an analog scale (0 being no pain and 10 significant pain).

Results

Follow-up averaged 24.6 months (range, 12–53). All fractures and nonunions united; there were no infections, elbow stiffness or heterotopic bone formations. Two patients had K-wires that got loose and needed removal under local anaesthesia before they protruded through the skin; their removal was performed 1.5 and three months postoperatively (Table 2). Three patients had postoperative ulnar nerve symptoms, and two of them recovered completely within the first four months. The third one still had altered sensation with no motor function loss but did not feel that a new release was needed at 12 months follow-up as there was no subjective alteration due to this sensitivity loss; this same

patient has now suffered an ipsilateral proximal humerus fracture after a fall, and is under orthopaedic treatment. One patient suffered a fracture of the distal humeral metaphysis after a car accident at the level of K-wire exit 14 months after the previous fracture; the treatment performed was tension band removal and double plating through a posterior paratricipital approach (Fig. 3).

DASH score at final follow-up averaged 14.2 points (range, 4–22); in fractures it averaged 13 points and in nonunions 16.6 points. The analog scale of pain averaged 1.1 points (range, 0–3). Elbow range of motion at last follow-up averaged 100° (range, 100–120°). Flexion averaged 123° (range, 115–130°) and elbow extension loss averaged 15.5° (range, 10–25°). All but one patient had complete pronosupination, and the remaining patient had loss of 30° in supination.

Discussion

In the 1960s the Arbeitsgemeinschaft für Osteosynthesefragen (AO) stated that the principles of management for distal humerus fractures are anatomical reduction, rigid fixation with double plating and early mobilization, and this way of approaching distal humeral fractures remains the gold standard in most fractures and nonunions, mainly when there is articular involvement [3, 4, 7, 9, 10]. But there are certain

Table 2 Results

DASH (final)	Pain	Flexion	Extension	ROM	Complications	Follow-up
15	1	125	−10	115	K-wire removed	48
18	2	115	−15	100	Distal humerus fracture	14
9	0	130	−10	120	K-wires removed	32
17	0	120	−20	100		17
15	1	115	−15	100	Ulnar nerve neurapraxia, proximal humerus fracture	12
4	2	130	−25	105	Ulnar nerve neurapraxia	22
12	1	115	−15	100		12
16	3	125	−20	120	Ulnar nerve neurapraxia	12
22	0	125	−10	115		53

Fig. 3 Fracture of the distal humeral metaphysis at the level of K-wire exit, treated by tension band removal and double plating through a posterior paratricipital approach

subgroups of distal humerus fractures that might benefit from tension band osteosynthesis. This fixation method adapts to the modern principles of fracture fixation established by the AO (flexible and biological fixation, that will allow prompt motion) as it involves less periosteal stripping and muscle damage than plate fixation, while allowing symmetrical compression, with also the advantages of being technically less demanding, faster and cheaper than plate fixation. Considering that we include only a subtype of distal humerus fractures and nonunions which are relatively rare, and that they have all been managed with the same treatment principles, and with good results, comparable to the other available fixation methods, we consider surgeons should have it in mind when leading with these particular subtypes of distal humerus fractures and nonunions. The main limitations of this series are its retrospective nature, not having a control group, and having a small number of patients.

In elderly patients open reduction and internal fixation of these lesions is justified and different fixation methods can be used [11]. Although the use of percutaneous K-wires is the fixation method of choice for supracondylar distal humerus fractures in children, the use of K-wires alone in distal humerus fractures in adults has given bad results and is not recommended [2, 4]. On the other hand, there is evidence supporting the use of tension band wiring in supracondylar distal humerus fractures with good functional results; Houben et al. [6] reported comparable results in ten patients with type C distal humerus fractures, five treated with double tension band osteosynthesis and five with double plate, for fixation of the condylar block to the shaft of the humerus. Zhao et al. [5] reported 24 patients with comminuted intra-articular fractures treated with double band osteosynthesis achieving 83 % excellent or good results. Allende et al. [7] reported on the use of tension bands in combination with other fixation methods for the treatment of intercondylar distal humerus fractures, concluding that they are a good alternative in comminuted distal

fractures with osteoporotic bone. In our group of patients, the average age was 70 years, all fractures and nonunions united, and the fixation achieved was adequate to allow prompt postoperative motion in all cases, as early motion was one of the main objectives in the treatment of these injuries.

The paratricipital approach avoids violation of the extensor mechanism of the elbow making it the favoured approach for extra-articular fractures; it can also be converted to an olecranon osteotomy approach for articular visualization, and it facilitates conversion to a total elbow arthroplasty [3]. Controversy remains regarding postoperative management of the ulnar nerve at the time of fixation [4, 12, 13], but it is generally accepted that it should be transposed anteriorly when the patient exhibits pre-operative ulnar nerve symptoms [3] because if left in place it will be in contact with the fixation performed and can be irritated by it during motion. In our patients the nerve was routinely transposed subcutaneously anterior to avoid contact with the tension band.

Locked plates have not yet proved to be superior to other fixation methods for distal humerus fractures, and their use remains controversial; there is currently insufficient evidence to recommend for or against their use in the management of distal humerus fractures [3], and they are probably recommended for comminuted and osteoporotic lesions [14, 15], but again there is no strong evidence to confirm this belief. On the other hand, there are some drawbacks in the use of these plates: the placement of precontoured locked plates needs more extensive soft-tissue dissection than tension band wiring; they are expensive, more time consuming, and technically more demanding; they do not always match precisely the anatomy of the reconstructed distal humerus; and differing from 3.5-mm reconstruction plates, they do not allow being moulded to adapt to the reconstruction achieved. When using tension bands, during wire tightening symmetrical compression is achieved at the lesion site and this compression will continue postoperatively. In osteoporotic bone even some

degree of shortening might be seen, but if appropriate alignment of the articular surface is maintained this shortening can substantially enhance the stability of the fracture and does not influence negatively the final result [16] (Fig. 2).

There is only one biomechanical study comparing tension band wiring with double plating for distal humerus fractures [17]; this study favours the use of double plating, but it has many important drawbacks as it was performed in dry cadaveric bone in which the mineral density of the specimens used was not determined, the specimens were detached of all soft tissues and joints, it was performed using only one K-wire on each column, the wire was passed around the tip of the K-wire proximally and distally and not through a hole drilled in the bone as used in the series we report, and lastly, the specimens were tested simulating a tensile force across the fracture, while the humerus is physiologically loaded in bending and compression.

Many different fixation methods have been used in recent years for the treatment of different types of distal humerus fractures; as these are infrequent lesions most series include many different fracture types in the same evaluation. The concepts stated in recent reviews in the treatment of distal humerus fractures that emphasize the fact that dual plate fixation, with placement of a separate strong plate on each column, is indicated for all adult fractures involving both columns of the distal part of the humerus [3, 4], is probably based on series including many different fracture types. It is our belief that, as it has happened with coronal shear fractures of the distal humerus, of which there are now multiple publications demonstrating that they need a different approach and fixation than the rest of distal humerus fractures [10, 18, 19], our series shows that transverse supracondylar fractures and nonunions in adults should not be systematically treated with double plating, and double tension band fixation can be a reliable, easy and cost effective technique for the management of these particular lesions and should remain an option to be considered when planning the stabilization of these fractures and nonunions.

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